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The Effects of Shift in Motivation Upon the Learning of a Sensori-Motor Task

BY
LORRAINE B. ABEL, Ph.D.

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CHAPTER I

INTRODUCTION

Since the question of motivation is such an important one at the present time to the economist, scientist, statesman, teacher, and many others, it is not surprising to find that it has in the past aroused (and still continues to do so) much experimental work in the field of psychology. Motivation is not only important in our adult life but is of the utmost significance in the development of the child. It serves as a means of social control, is of importance in the formation of habits and the acquisition of skills and knowledge, and aids in building up, what society considers to be, an appropriate attitude toward life.

Since the terms, ''drive,'' ''incentive,'' and ''motivation'' are so frequently used as synonyms in every-day life, the opportunity is being taken here to define them as they are most commonly used in psychological experimentation. Warden (28, pp. 14–15) has distinguished them as follows: An ''incentive,'' according to his terminology, is an external object which is capable of operating as a stimulus and of arousing some definite internal physiological state. It is limited to those objects that satisfy from the observer's point of view some fairly definite drive or seeking tendency. A ''drive'' is an aroused reaction tendency which is characterized primarily by the fact that the activity of the animal is directed toward or away from some specific incentive. It does not refer to the physiological state aroused by an incentive or by deprivation of some sort, but to a behavior tendency resulting from the internal arousal. The term ''motivation'' is used to cover both the incentive and the drive aspect of the behavior investigated.

In both the animal and the human field, the conditions of motivation may, on the whole, be classified, according to this same authority, under the three following ''combinations'' (29, p. 177):

1. Reward-punishment.
2. Reward-neutral.
3. Punishment-neutral.

In the above instances, the term ''neutral'' is taken to mean ''lack of any special incentive''.

So many excellent surveys have been made of the literature on motivation, such as those by Dashiell (9, pp. 229–274; 325–385);

Diserens and Vaughn (10) ; Bills (2, pp. 258–274) ; and Young (32, pp. 266–317) ; that it is unnecessary to add to the work already done.

In the animal field, the results point to ''reward-punishment'' as the most effective type of motivation and to ''punishment-neutral'' as more effective than ''reward-neutral.''

In the human field, approximately the same results as to the relative importance of these combinations have been obtained. Knowledge of results and of progress made always seems to cause a decided improvement in learning. The possession of an aim or purpose also seems to facilitate learning. The relative influence of praise and blame is impossible of decision in most experiments, since chronological age, mental age, and sex differences may affect any interpretation.

CHAPTER II

HISTORICAL BACKGROUND

Due to the existence of the excellent reviews of motivation literature to which attention has already been called (see pp. 5–6) a survey is being made only of those experiments which have employed the same type of technique as the present problem, that of motivation-shifting.

In the animal field Simmons (24) in 1924 used two groups of rats, a control group and a delayed incentive group. In the experimental group, the animals were rewarded with bread and milk from the sixth trial on, while in the control they were rewarded from the beginning of the learning period. She found that the delayed incentive group, after the ninth trial, showed more improvement than did the control. Blodgett (4) in 1925 obtained similar results when he ran rats in a maze without food for various periods of time (3, 7, and 16 days) during which they showed little improvement. When the reward was introduced (*i.e.,* at the end of each of these periods), the animals almost at once showed a performance equalling that of the control groups which had been receiving food throughout the training period. He infers from this that a ''latent learning'' had been taking place but had not been measured until the food reward had been introduced.

Warden (27) attempted in 1925 to discover the value of preliminary feeding in animal learning experiments. He used two groups of white rats, 14 in each group, in a problem box. The training period covered a total of 27 days. Group A was fed in the inner cage of the apparatus for 10 minutes on 7 successive days, and then given 20 trials at the rate of one per day. During the feeding, the door of the inner cage was left open, permitting exploration of the area within the outer cage. Group B was given one trial per day for the first seven days of the training period, and then 20 additional trials at the rate of one daily. In both groups milk-soaked bread was given as a reward upon successful entry into the inner cage. He found that the 70 minutes of exploratory activity on the part of Group A was equal to the first seven trials of Group B.

Elliott (12) in 1928 attempted to determine the effect of change to a new reward on rats which had learned to run a maze for a certain reward. For the first nine days, the animals were rewarded with bran mash after their daily trial. On the tenth and thereafter, they received sunflower seed. The experimental group showed the usual improvement in performance for the first ten days, but the introduction of a new reward on the tenth caused an increase in both time and error scores on the eleventh and following days.

Williams (30) that same year used three groups of rats, which were first trained for 10 days in a simple white-black discrimination box. Of the control groups, II, when run in a 14 unit Multiple T maze, never found food at the end of the maze but found instead a new, strange, empty, unpainted goal-box in which they were confined for 30 seconds. Group III found the familiar discrimination box, used in the training period, in which food had been placed. Group I, the experimental group, found (like II) the unfamiliar box for the first 8 days. On the ninth, it found the familiar discrimination box but with no food inside. This group, nevertheless, showed a decided improvement, so that on the thirteenth day, its curve approached that of Group III. She concluded, therefore, that a conditioned-stimulus might have a reward value.

Blodgett (3) the following year attempted to study the efficiency of units of practice when unaccompanied by reward. Group I, the control, was rewarded with food at the end of the daily maze trial over a period of 7 days. Group II found no food in the food box for the first six days but were kept in it for two minutes and then removed. On the seventh and subsequent days, they were treated like Group I. Group III, like II, began with no reward at the end of the maze, but for them it was introduced at the end of the third day. The results show that II and III, as long as they were without reward, did very much worse than I, but that on the day after the first reward, their errors dropped greatly and on the second, the curves had almost dropped to the level of that of I. He concludes that non-reward running definitely develops a latent learning which is made manifest when reward is introduced.

Elliott (11) in the same year performed an experiment to study the effect of a change of drive on maze performance. Two groups of rats were given a daily trial on a 14-blind Multiple T maze. Group I was kept very thirsty and was rewarded with water for the first nine days. On the tenth and succeeding days, they were kept hungry and rewarded with a standard mixed diet. Group II, the control, consisted of animals that were kept thirsty and were rewarded with water. It was found that the change in conditions on the tenth day caused an increase in the average time and errors of Group I, which the author ascribed to "expectation" of a reward unsuited to the new drive. When the new and appropriate reward (food instead of water) was discovered, the learning curve resumed its downward course and continued just as if there had been no change. He therefore concluded that a reward may be changed without affecting the learning curve provided that the drive was so changed as to maintain an appropriate relationship between it and its reward.

Hamilton (16) used 105 male albino rats in running a maze. When, with a delayed reward, a high norm of mastery was used (4 perfect trials out of 5), she found that 9 of these failed to learn by the end of the 99 trials, although all had learned by the fiftieth trial under a low norm of mastery (2 perfect trials out of 3). When the conditions were changed from a delayed to an immediate reward, there was a markedly favorable effect on the performance of these animals. Their time and error scores decreased immediately and all of the animals learned within 5 trials after the change in motivation, although they had made little or no progress for approximately the last 50 trials before this change.

Sharp (23) in 1929 used two groups of rats, both of which were given one trial per day on a maze until it was thoroughly learned and rewarded with a food incentive. Conditions were then changed: one group no longer received the reward; the other group was given it as usual. After the change in motivation in the first group, the experimenter found an increase in the time and errors made and a greater variability from trial to trial. Bruce (6) in 1930 performed a similar experiment with almost the same results.

Tolman and Honzik (25) in the same year made an attempt to study the effect of a change of motivation during the course of the learning process. Group I (HR), the control group, was given a food reward at the end of the daily maze trial. Group II (HR–NR) was given this reward for the first ten days but had it withdrawn on the eleventh and subsequent days. Group III (HNR–R) was rewarded with food from the eleventh day on. The results show that Group II made large increases in time and error scores when the reward was removed. Group III made large decreases in time and error scores when the reward was introduced. A drop in the errors on the eleventh day brought their curve significantly below that of the control group which had been rewarded from the first day. This suggested to the authors the possibility that latent learning might be more effective than overt. Woodworth (31, pp. 230–231), however, suggests another explanation for the performance of the rats. He is of the opinion that if the rat is not rewarded for the first ten trials, that it just continues its exploratory behavior and seems to be learning nothing. After the reward is introduced, the animal ceases wandering and eliminates the blind alleys much more rapidly than can be done by an animal wholly new to the maze. Exploring seems to teach the rat the maze as a "locality". When the reward is given for the first ten trials and then stopped, the animal at once drops back into the exploratory type of behavior and enters many blind alleys which it had already eliminated. From this it would seem that a rat becomes well acquainted with a locality by exploring it, even though there is no definite goal to steer for; but where there is a goal, the animal steers for it. Woodworth therefore concludes that what the rat primarily learns is the plan of the maze and within it the direction of the goal and the path to the goal. The supposition that exploring seems to teach the rat the maze as a "locality" is borne out in part by Warden's experiment (27) which has already been described (see p. 7). He found that 70 minutes of exploratory activity in the problem box on the part of the rats in Group A was equal to the first seven trials in the learning period of Group B.

Bruce (7) in 1932 ran groups of rats in a maze with a food incentive. In one group, after a certain number of trials, the reward was removed, and the investigator found that there was a significant rise in the excess distance run and in the time. In Part III of his work he varied the procedure, by removing the food reward and placing it behind a wire mesh. When this was done there was a significant rise in time and the excess distance scores. There was also a significant difference between this group and a group from which the food had been entirely removed, the rats of the former group doing less running about in the maze and consuming less time.

Stein, in an unpublished experiment under the direction of Dr. Young (32, pp. 100–102), trained a group of rats in an apparatus arranged on a teeter-totter device, at the ends of which food cups had been placed. The rat was permitted to eat from one cup five seconds and the food was then removed. He was then allowed to run to the second cup and eat there another five seconds. The animals were thus trained 15 minutes daily with a given food incentive until the limit of practice was reached (approximately 20 days). The number of runs per minute was then tallied. The incentive was then shifted to that of another food of a known preferential rating (butter fat which is very low in the scale) for days 21 through 25. On days 26 and 27 the incentive was shifted to that first used. Stein found that there was a decline in activity when butter fat was used as an incentive but that there was an abrupt rise when the reward was shifted back to that first used. In another experiment he used the same technique but substituted flower seed for the first incentive given (which was fresh milk). The results obtained were similar to those found in his first experiment.

. . . .

In the human field Book and Norvell (5) in 1922 did some of the first work using a shift in motivation. They studied the practice gain of 124 college students in simple tasks involving the cancellation of letters, two-place multiplication, and so on, over a long practice period. The ''will'' group were told of their previous scores and urged to surpass them. The control group were told nothing. Not only did the stimulated group improve much faster, but the control group, when stimulation was later introduced, suddenly leaped ahead at a rapid rate.

Ross (22) in 1929 tested the improvement of 59 college students in the motor task of ''tallying'' and systematically varied the amount of the information given. The individuals in Section I were given full knowledge of their progress; they knew what record they were making and how it compared with their previous record. Section II was given only partial knowledge and merely knew who were above and below the average. Section III was given no information at all. At the end of 9 practice periods the conditions of the two experimental groups were reversed. Before the change Section I had gained 2.2% to 8.5% more than II and 4.5% to 12.6% more than III. When the conditions were shifted, the experimenter found no reversal in the relative positions. Although this is contrary to the finding of Book and Norvell, it cannot be said that it contradicts their results, since Ross gave only 3 practice periods after the shift in motivation, and it cannot be known what results a continuation of the practice periods might have caused.

McKinney (19) in 1931 gave students of college level a stylus maze problem to learn, and found that when he suggested to them that they were not doing as well as their peers, that their learning time and errors were considerably increased. He found the same results when he used this procedure with subjects learning lists of nonsense syllables.

As is very evident from this review of the experiments using a shift in motivation, the work has for the most part been done in the animal field. The experimentation has been very thorough and the results fairly clear cut. It has been generally found that a shift in motivation brings with it a shift in the learning curve. With a change from reward to no-reward, there is usually an increase in the time and number of errors made. With a change from no-reward to reward, there is usually a decrease in the time and errors. When a shift is made from an appropriate reward (by this I mean a reward appropriate to the drive) to a non-appropriate reward, there is usually an increase in the time and errors. When the change is in the opposite direction, there is usually a decrease in the time and errors. When the shift is from one appropriate reward to another appropriate reward, there is a slight increase in the time and errors for a short period of time, after which the normal learning curve is resumed.

Blodgett (3) and Tolman and Honzik (25) found in their experiments that rats run in a maze without food made little improvement, but that with the introduction of reward, they almost at once showed a performance equalling that of the control group which had been receiving a reward straight through the learning period. They state that this sudden drop in the error curve when reward is introduced is a manifestation of ''latent learning''; that is, that learning had been going on but had not been made apparent until the introduction of reward.

CHAPTER III

STATEMENT OF PROBLEM AND CHOICE OF SUBJECTS

Since the work in the human field has been so sparse and the results not very conclusive, the problem as to the effects of motivation-shifting on the individual is practically untouched. What will be the effect of changing from no-incentive to an incentive on the learning of a particular task? What will be the effect of changing from a verbal incentive to a material incentive on the learning process? Is there anything comparable to Tolman's ''latent learning'' in rats to be found in human learning? It was with a view to answering these questions as completely as possible that the present investigation was undertaken.

To narrow down the general problem of the effect of a shift in motivation on the learning process of a human being, required its translation to more specific experimental terminology. In the animal field, the conditions under which the subject performs a given task are to a large extent under the control of the investigator. In the human field, this is, of course, not true since the individual is swayed by emotions and desires over which the experimenter has no control. The experimental conditions must be kept, therefore, as simple as possible and as much as possible under the guidance of the investigator. It was decided to limit the question of motivation to a study of the effect of a change of reward upon the learning of a fairly simple task.

Since what is a reward to one person may not be a reward to another, an incentive had to be found which would uniformly motivate a given group of subjects. As it is almost impossible to find a situation which will have the same effect on any two adults, it was decided to use children as subjects. Their selection necessitated a task fairly simple in its nature, the mastery of which might be attained in a comparatively short sitting. To fulfill these requirements the Warden Multiple-U maze, finger type (26) (17) (20) was chosen. The raised finger maze was used, rather than the stylus, as the manipulation of the latter constitutes in itself a technique not easily acquired by children. It was decided to use two types of rewards, material and verbal. Money was fixed upon as perhaps the most effective type of material reward if the child were permitted to buy with it whatever he wished (candy, a ball, or something of the sort). Praise was used as a kind of verbal reward.

The shift in motivation was introduced at the middle of the learning period for the following reasons:

1. to determine whether its effect upon learning was immediate, in which case there would be a sudden significant drop in the error curve, or
2. whether its effect upon learning was delayed, in which case there would be a gradual drop in the error curve, or
3. if it had no effect at all upon learning, in which case the slope and the general level of the error curve would be the same before and after the change;
4. to serve as a basis for comparison with the effects of a continuation of a given motivation;
5. to determine whether or not in human learning there might be found a phenomenon similar to Tolman's "latent learning."

The problem to be investigated was therefore narrowed down to the following: to study the effects of a change of motivation (from no reward to a material reward and from a verbal reward to a material reward) upon the learning of a sensori-motor task, the Warden Multiple-U maze, finger type.

CHAPTER IV

APPARATUS AND PROCEDURE

Since the Warden Multiple-U maze, finger type, had not previously been used with children, the investigator was compelled to experiment until the best procedure for the lowest age-group possible was found. She therefore selected ten children of average intelligence (*i.e.,* with IQ's ranging from 90 to 110) for each age-year from seven to eleven, inclusive, and experimented with various techniques until it was found the most satisfactory results were to be obtained by the use of a given procedure with the nine-year old group.[1] This procedure was then tried out with 19 nine-year olds of average intelligence (from P. S. 119, New York City) and additional modifications made. In the form finally used for the investigation the procedure is as follows:

> The subject, seated comfortably at a small table facing the experimenter, is shown a practice raised finger maze which had been previously arranged by the author (see diagram I, p. 16) and instructed, "Now I want you to pretend that these (pointing to raised pathways) are roads and that you are in an automobile going from here (pointing to S) to here (pointing to G). I want you to show me with your finger how you would go from here (again pointing to S) to here (again pointing to G)." The subject is then allowed to trace the maze with his finger. He is then asked, "Why didn't you go here?" (E points to "b," a blind alley.) On receiving the response from the subject that he had not because the road came to an end at that point and he would only have had to retrace his path, the experimenter says, "And that's why you must not go here (points to "c") or here (points to "a"), isn't it? Now I want to see if you can trace these roads with your eyes closed." When the subject has performed this successfully, he is told, "I have here another maze which is something like this one, but a little bit different (see diagram II, p. 16). I'm going to let you do it once with your eyes open and then I'm going to blindfold you and see how quickly you can learn to trace it that way without making any mistakes." The subject after

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[1] These subjects were obtained from Recreation Rooms and Settlement, 86 First St., New York City.

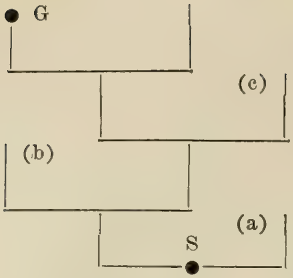

DIAGRAM I

Practice Finger Maze

S—starting point
G—goal
a, b, c—blind alleys

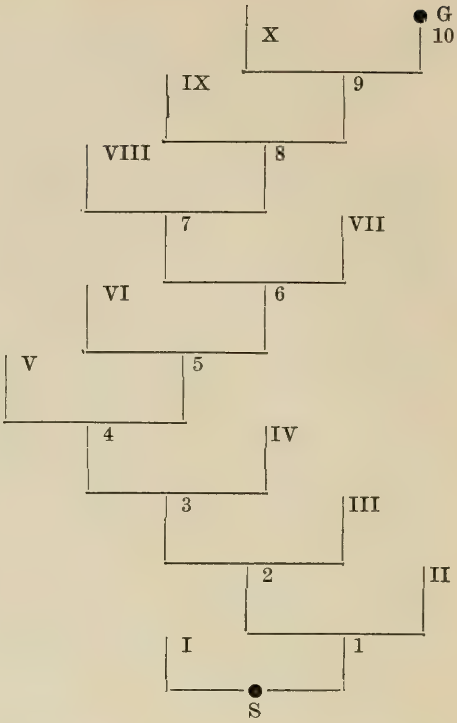

DIAGRAM II

Warden Multiple—U Maze Finger Type
S—starting point
G—goal
I, II, . . . X—blind alleys
1, 2, . . . 10—correct paths

his first trial on this Warden Multiple-U maze, finger type, with his eyes open, is then blindfolded and given a preliminary trial, following which the thirty trials constituting the learning period are made.

CHAPTER V

EXPERIMENT ONE

Since the investigation purported to study the effects of motivation-shifting (from no-reward to material reward and from verbal reward to material reward), it was necessary to use three control and two experimental groups. The control groups were as follows: Group I, in which no reward was given and which is referred to throughout the experiment as the ''no-reward'' group; Group II, in which a material reward (a penny) was given at the end of each trial and which is referred to as the ''material reward'' group; and Group III, in which a verbal reward was given at the end of each trial and which is referred to as the ''verbal reward'' group. The two experimental groups were: Group IV, in which no-reward was shifted to material reward in the middle of the learning period and which is referred to as the ''no reward-reward'' group; and Group V, in which verbal reward was shifted to material reward in the middle of the learning period and which is referred to as the ''verbal reward-reward'' group.

Section I: Subjects, Procedure, Treatment of Data

Subjects

Since the procedure for the learning of the raised finger maze had been standardized on nine-year olds, the subjects of this experiment had to, perforce, come from that age range. The National Intelligence Test (15) was therefore administered to all fourth, fifth, and sixth grade children of P. S. 166, New York City. The youngsters came from homes of the lower middle class; that is, of fathers who were skilled laborers, small shopkeepers, etc. Of these, 100 boys with a CA from 9 yrs., 2 mos. to 10 yrs., 1 mo. and whose IQ's ranged from 100 to 129 were chosen and divided into the five groups previously described. The groups, obviously above the average in general intelligence, were equated according to CA and MA.

Since the range in chronological age was confined to that of one year but since the range of mental age was in some cases three times as great, it was decided to find whether or not there was a significant difference between the mental ages of any of the groups. With this in mind the D/sigma D's of the means (the actual difference

TABLE 1

SHOWING THE AVERAGE, THE RANGE, AND THE SIGMAS OF THE DISTRIBUTION OF THE CHRONOLOGICAL AND MENTAL AGES OF EACH OF THE GROUP

Group	*C.A.*			*M.A.*		
	Average	*Sigma*	*Range*	*Average*	*Sigma*	*Range*
I	9–5	.395	9–2 to 10–1	11–3	.852	9– 9 to 12–7
II	9–6	.290	9–2 to 10–1	11–2	.765	9–10 to 12–7
III	9–8	.290	9–2 to 10–1	11–2	.717	9– 2 to 12–6
IV	9–7	.330	9–2 to 10–1	11–2	.767	9– 6 to 12–7
V	9–7	.353	9–2 to 10–1	11–3	.745	9–10 to 12–6

between two means divided by the sigma of the difference) were calculated (14, pp. 128–134).

TABLE 2

SHOWING THE CHANCES OF A TRUE DIFFERENCE GREATER THAN ZERO EXISTING BETWEEN THE MEANS OF THE MENTAL AGES OF THE FIVE GROUPS

Groups	*D/sigma D*	*Chances in 100*
I and II	0.316	62
I and III	0.333	63
I and IV	0.324	62
I and V	0.000	50
II and III	0.000	50
II and IV	0.000	50
II and V	0.344	63
III and IV	0.000	50
III and V	0.365	64
IV and V	0.352	64

As can be readily seen from the above table, any difference existing between the means of the mental ages may be put down to chance for in no case is there evidence of a reliable difference.

Motivation Procedure:

The administration of the motivation in each of the five groups is described briefly as follows:

Group I—*No reward (NR) group*—30 trials no reward. Procedure followed as described in Chapter IV, pp. 15–16.

Group II—*Material reward (MR) group*—30 trials material reward. Procedure like that of no-reward group with the exception of the introduction of the material reward. At the end of the preliminary trial the experimenter says, "Here is a penny for you to keep." A glass dish is placed at the child's side into which he may drop the penny as it is given to him. This procedure is then followed for the remaining trials.

Group III—*Verbal reward* (*VR*) *group*—30 trials verbal reward. Procedure like that of no-reward group with the exception of the introduction of a verbal reward. At the end of the preliminary trial E says, "Good!"; at the end of trial 1, "Very good!"; at the end of trial 2, "Fine! Let me see if you can make even *less* mistakes next time." These three verbal rewards are rotated for the remainder of the trials.

Group IV—*No reward-reward* (*NR–R*) *group*—15 trials no reward; 15 trials material reward. During the first half of the learning period the procedure is the same as that of the no-reward group. At the end of the fifteenth trial, however, the material reward, in the form of a penny, is introduced, and the procedure follows that of Group II.

Group V—*Verbal reward-reward* (*VR–R*) *group*—15 trials verbal reward; 15 trials material reward. During the first half of the learning period the procedure followed is like that of Group III; at the end of the fifteenth trial, the material reward, a penny, is introduced and the procedure follows that of Group II.

Scoring:

The number of errors made in each trial was recorded and the time of each trial measured in seconds. An error was considered as made only when the subject's finger had actually touched the end of a blind alley. The criterion of mastery was taken as two successive errorless trials, since it had previously been found with the pre-experimental group at P. S. 119 that an individual, having made two successive errorless trials, in 90% of the cases went on making errorless trials for the remainder of the learning period. Therefore when a subject had mastered the maze, the rest of his trials were automatically scored as "zero" even though he was not asked to perform them. This was done to save time and to prevent the subject from becoming bored with the task. All cases in which the maze was mastered before the twentieth trial were discarded and new subjects substituted. The comparatively few instances in which the maze was mastered after the twentieth trial were included in the final tabulation of results since they occurred so late in the learning period as not to affect the average scores to any appreciable extent. The number of cases and the points at which the individuals reached the criterion of mastery are tabulated as follows:

Group	*No. Individuals Mastering Maze*
I	2 (1 at trial 26, 1 at trial 27)
II	3 (1 at trial 21, 1 at trial 25, 1 at trial 26)
III	3 (1 at trial 26, 1 at trial 27, 1 at trial 29)
IV	2 (1 at trial 24, 1 at trial 27)
V	3 (1 at trial 21, 1 at trial 24, 1 at trial 27)

Treatment of Data:

The average number of errors made by each of the five groups for each of the thirty trials constituting the learning period was tabulated (see table 3, p. 21) and the data for each group plotted (see figures 1, 2, 3, 4, and 5, on pp. 22, 23, and 24, respectively). Although the curves of average error may be compared through observation, it was thought that their similarities and differences might be seen a little more clearly if their ''trends'' were taken into account (21).

The notion of definite ''trend'' implies a regular, smooth underlying movement, from which there are deviations, but which marks the tendency of the series of data and which may be represented by a mathematical curve. Thus, if growth or decline is by constant absolute increments or decrements, a straight line will serve as an exact representation of the trend, and a curve of a definite mathematical form will furnish the best representation of this trend (21, pp. 252–314). The task of fitting the trend line to the data is then merely the determination of the constants in an equation of the form, $y = a + bx$, the constants being determined by the method of ''least squares'' (21, pp. 273–278). When the data are not accurately fitted by a straight line trend, a curve of higher degree may represent the trend more accurately. The generalized form of the equation of the type desired is $y = a + bx + cx^2 + dx^3 \ldots$ (21, pp. 280–284). Although an equation of this form does not, of course, represent a curve of the parabolic type, that term is applied, in statistical usage, to those of higher degree. If carried to the second power of ''x'' it is called a second degree parabola; if to the third, a third degree parabola, etc.

The most difficult problem has to do with the question of selec-

TABLE 3

SHOWING THE AVERAGE NUMBER OF ERRORS MADE BY EACH OF THE FIVE GROUPS FOR EACH OF THE THIRTY TRIALS IN THE LEAPNING PERIOD

Trial	*Av. No. of Errors Made*				
	Group I	*Group II*	*Group III*	*Group IV*	*Group V*
1	4.15	4.16	4.90	4.35	4.30
2	4.05	3.83	3.65	4.15	4.65
3	4.21	3.77	4.30	3.85	3.80
4	4.05	3.83	3.90	4.00	3.30
5	3.36	3.44	3.55	3.85	3.60
6	3.42	3.55	3.65	3.50	3.70
7	3.63	3.00	3.85	3.85	3.00
8	3.52	3.94	3.60	4.00	3.40
9	3.63	3.27	3.30	3.75	3.55
10	3.94	3.33	2.60	3.45	3.65
11	3.78	3.11	2.75	3.70	3.80
12	3.00	3.27	3.20	3.60	3.40
13	3.26	3.38	3.30	3.55	3.70
14	3.00	3.22	3.40	3.10	3.10
15	3.21	3.16	3.25	3.10	3.55
16	3.36	2.50	2.85	2.90	3.15
17	3.73	2.55	2.95	2.40	3.55
18	3.36	2.61	2.35	2.15	2.85
19	3.36	2.66	2.85	2.40	2.65
20	3.57	2.38	2.60	2.15	2.75
21	3.57	2.44	2.80	2.40	2.75
22	3.36	2.55	2.50	2.35	2.55
23	3.05	2.05	3.05	2.80	2.60
24	3.00	2.21	2.45	2.10	2.40
25	2.84	1.88	1.60	2.35	1.95
26	2.94	2.00	2.85	2.20	1.95
27	3.00	1.77	2.40	1.95	1.75
28	2.68	1.72	2.20	1.60	1.70
29	2.31	1.61	1.75	1.35	1.90
30	2.05	1.05	2.25	1.25	2.20

tion of the type of curve to be fitted to the data. There is no absolute test of goodness of fit. It is largely a matter of personal judgment as to the type of curve which best represents the data in a given instance. When a study of the original data did not render a definite decision possible, several types of curves were fitted to the data and the decision made by comparing the results. A comparison of the sigma deviations about the curves usually furnished a fairly conclusive and valid test of the closeness of the fit within the limits of the data (21, pp. 562–580).

In two cases (see figs. 1 and 2, p. 22) the trend lines were straight lines; in one case (see fig. 3, p. 23) a second degree equation was used; and in one case (see fig. 5, p. 24) a third degree equation was used. To determine the effects of a change in motivation on the

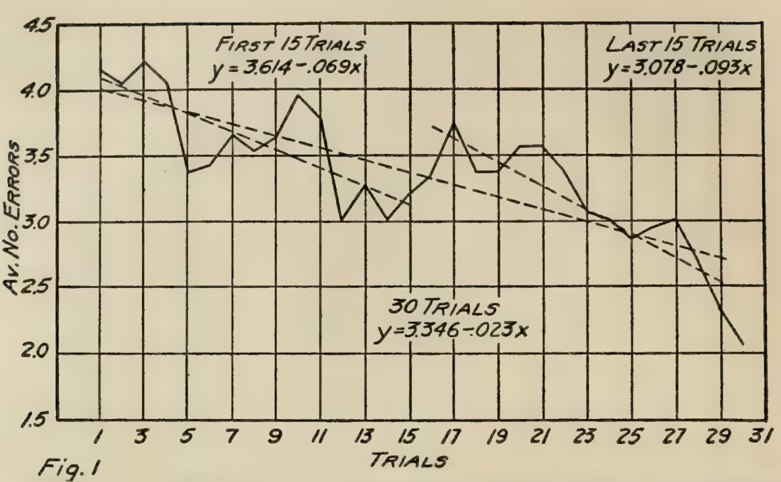

Fig. 1

GROUP I—No Reward Group: showing the average number of errors made by the group for each of the thirty trials; the trend line for the learning period as a whole; and, the trend lines for the first and second halves of the learning period.

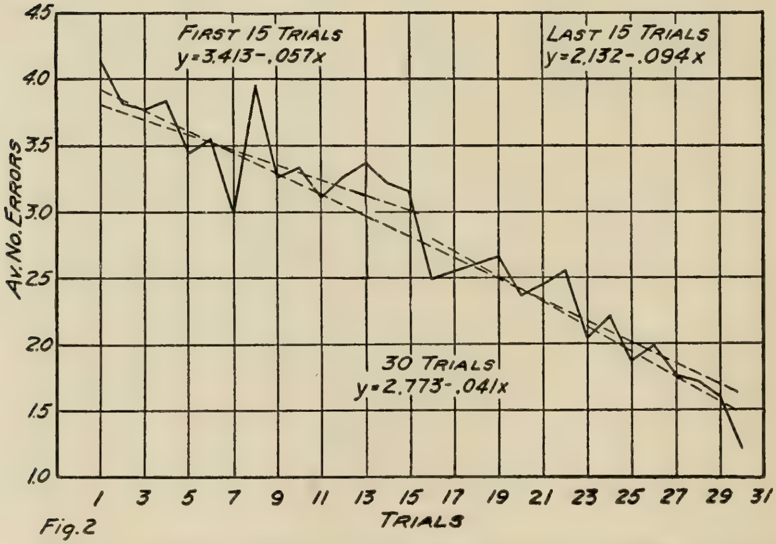

Fig. 2

GROUP II—Material Reward Group: showing the average number of errors made by the group for each of the thirty trials; the trend line for the learning period as a whole; and, the trend lines for the first and second halves of the learning period.

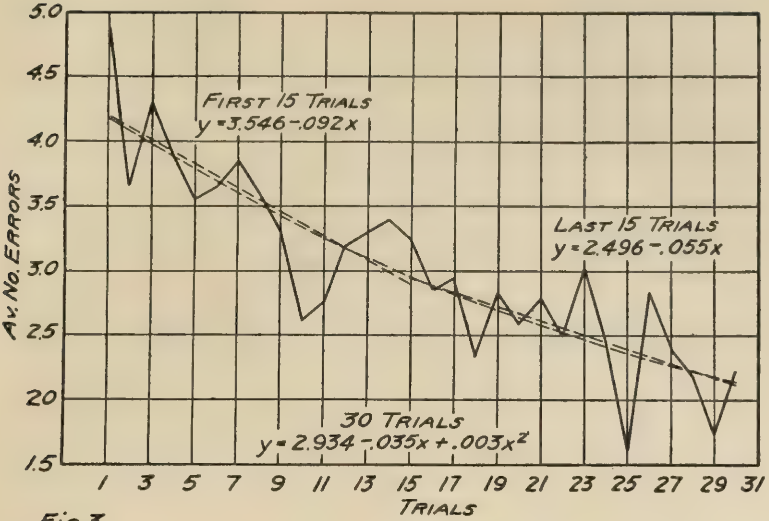

Fig. 3

Group III—Verbal Reward Group: showing the average number of errors made by the group for each of the thirty trials; the trend line for the learning period as a whole; and, the trend lines for the first and second halves of the learning period.

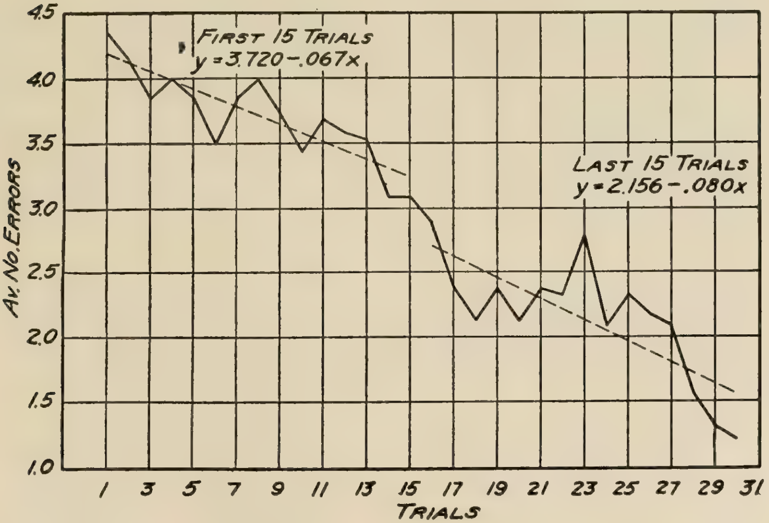

Fig. 4

Group IV—No Reward-Reward Group: showing the average number of errors made by the group for each of the thirty trials; the trend line for the learning period as a whole; and, the trend lines for the first and second halves of the learning period.

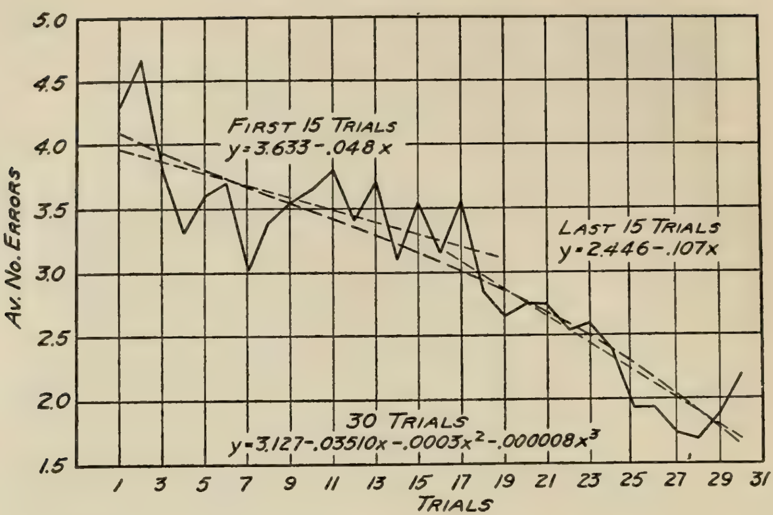

Fig. 5

Group V—Verbal Reward-Reward Group: showing the average number of errors made by the group for each of the thirty trials; the trend line for the learning period as a whole; and, the trend lines for the first and second halves of the learning period.

learning curve, the learning periods of Groups IV and V were divided into 2 halves and a line of trend calculated for each series of data (for trials 1 through 15 and for trials 16 through 30). The same procedure was followed with regard to the learning periods of the control groups (I, II, and III) with a view to comparing the effects of a change in motivation with the effects of the continuation of a motivation (see table 4, p. 24).

The next question to arise was the method of determining

TABLE 4

Showing the Trend Lines for Each of the Five Groups: That Is, for the Whole Learning Period, for the First Half of the Learning Period (Trials 1 Through 15), and for the Second Half of the Learning Period (Trials 16 Through 30)

Group	*Whole learning period*	*Trials 1 through 15*	*Trials 16 through 30*
I (NR)	$y = 3.346 - .023x$	$y = 3.614 - .069x$	$y = 3.078 - .093x$
II (MR)	$y = 2.773 - .041x$	$y = 3.413 - .057x$	$y = 2.132 - .094x$
III (VR)	$y = 2.934 - .035x + .003x^2$	$y = 3.546 - .092x$	$y = 2.496 - .055x$
IV (NR–R)	(no trend line)	$y = 3.720 - .067x$	$y = 2.156 - .080x$
V (VR–R)	$y = 3.127 - .035x - .0003x^2 - .000008x^3$	$y = 3.633 - .048x$	$y = 2.446 - .107x$

whether or not a reliable difference existed between the two halves of the learning period and whether or not a reliable difference existed between their learning rates. Since each half consisted only of fifteen trials, the procedure to be adopted had to be one which would take into account the small number of cases. Using Fisher's method, P varies with the number of cases and will give the number of chances in 100 that the difference obtained between any two measures is due to sampling alone (13, pp. 75–139). For example, let us suppose that we wish to determine whether the difference existing between the means of two groups (each consisting of 15 subjects) is a reliable one or whether it is due to "chance". P is found to be .10, which may be interpreted as meaning that there are 10 chances in 100 that the difference obtained is due to sampling; or from another point of view, that there are 90 chances in 100 that the difference obtained is significant. When the P is .05 or less, any difference that is found is regarded as reliable (13, p. 79). Now, let us suppose that we had the same difference as found between the means of the before-mentioned groups, but that the number of subjects in each group was much smaller,—for example, three. In that case, despite the fact that the difference is still the same, we would find that the P, which must be interpreted according to the number of cases, had increased to .25 and now instead of there being 10 chances in 100 for the difference being due to sampling, there are 25. The P, therefore, allows for the fact that the smaller the number of cases used, the greater the chance for sampling error. When we wished to determine whether there was a reliable difference between the rates of learning of the two halves of a learning period, the P of the difference between the two slopes of the trend lines was calculated. It

TABLE 5

SHOWING THE P/2 OF THE DIFFERENCE BETWEEN THE MEANS OF THE TWO HALVES OF THE LEARNING PERIOD OF EACH GROUP AND THE P/2 OF THE DIFFERENCE BETWEEN THE RATES OF LEARNING (AS INDICATED BY THE SLOPE OF THE TREND LINE) OF THE TWO HALVES OF THE LEARNING PERIOD OF EACH GROUP

Group	*P/2 of diff. between means*	*P/2 of diff. between slopes*
I (C)	0.005	0.27
II (MR)	0.000	0.15
III (VR)	0.000	0.20
IV (NR–R)	0.000	0.39
V (VR–R)	0.000	0.00

is the coefficient of the "x" term which gives the slope, or rate of learning, in a straight line equation, the form of which is $y = a + bx$. The first term gives the level of the point about which the trend line swings. The difference between the "x" terms of the two equations was therefore found and the P of this difference computed. It is interpreted in the same way as the P of the difference between two means. However, since our main interest lay in whether or not a difference was likely to be *less* than that obtained, and not whether it was likely to be greater, the P in all cases was divided by 2, and P/2 used for inter-comparisons (see table 5, p. 25).

SECTION II: DISCUSSION OF RESULTS

Group Results

1. *No reward group*

The raw data of this group show a gradual downward trend best fitted by the straight line equation, $y = 3.346 - .023x$. When the learning period was divided into 2 parts, the trend line for the first half was found to be $y = 3.614 - .069x$ and for the second, $y = 3.078 - .093x$. To find whether or not there was a reliable difference between the average number of errors made in the first and second halves, the P/2 of the difference between their means was computed and found to be .005. This may be interpreted to mean there is only 1 chance in 200 that the difference obtained, or a lesser difference, can be due to sampling error. We may say, therefore, that there has been a significant reduction of errors over the course of the period and that this reduction signifies that learning has taken place. By glancing at the trend lines, it is evident that the slope of the second is greater than that of the first. Since the slope indicates the rate of learning, it was necessary to determine whether the difference between these slopes was reliable. The P/2 of the difference was computed to be .27 which means that there are 27 chances in 100 that this difference is due to sampling error. We can infer from this that the slight difference between the rates of learning in the two halves is merely a chance one.

2. *Material reward group*

The striking feature about the data of this group is the steep downward course which is taken, the form of which is best fitted by the straight line equation, $y = 2.773 - .041x$. When the learning period was divided, the trend lines for the first and second halves were $y = 3.413 - .057x$ and $y = 2.132 - .094x$, respectively. A P/2 of 0.00 of the difference between the means of the two halves indicates that there is no chance whatsoever that this difference may be due to sampling error. In other words, there is evidence that learning has taken place. When the slopes of the two lines were compared, it was obvious that the latter was considerably greater than the former. However, since the P/2 of the difference between them was .15, it means that there are 15 chances in 100 that this difference is due to chance.

3. *Verbal reward group*

This group shows a rather pronounced slope in the error curve up to the tenth trial. Thereafter it becomes less and less marked. The data are best fitted by the second degree equation, $y = 2.934 - .035x + .003x^2$. The trend lines for the first and second halves of the learning period were found to be $y = 3.546 - .092x$ and $y = 2.496 - .055x$. A P/2 of 0.00 of the difference between their respective means indicates that there is no chance that the difference may be due to sampling. In other words, this group also shows definite evidence of learning. When the rates of learning are compared by inspection of the slopes of the trend lines of the 2 halves, it is evident that the group learned faster in the first part of the period. When the P/2 of the difference between these slopes was computed, it was found to be .20; that is, that there are 20 chances in 100 that this difference in rate may be due to sampling, or chance error.

4. *No reward-reward group*

The most striking feature about the data of this group lies in the sudden drop which the error curve takes at the end of the fifteenth trial, after the introduction of the material reward. Several types of curves (a straight line, a second, and a third degree equation) were fitted to the data and a comparison of the sigma deviations (21, pp. 562–580) about the curves made. In no instance was there found a curve that gave a close fit to the data. It was evident, therefore, that to all intents and purposes, two different groups of data were present, and with this in mind the two halves of the learning period were treated separately. The first was fitted by a straight line equation, $y = 3.720 - .067x$ and the second by another straight line equation, $y = 2.156 - .080x$. As would be expected from the above, when the P/2 of the difference between their two means was calculated, it was found to be 0.00; that is, that the existent difference was not a chance one. When the trend lines were inspected, it was obvious that their slopes were very much the same. This supposition was borne out by the fact that the P/2 of their difference was computed to be .39; that is, that there are 39 chances in 100 that the difference obtaining is due to sampling. In other words, while the general level of the second half of the learning period is much lower than that of the first, the rate of learning, after the drop in the error curve, remains practically the same.

5. *Verbal reward-reward group*

In this group the drop in the learning curve is gradual until the seventeenth trial is reached, after which point it becomes more marked. A third degree equation, $y = 3.127 - .035x - .0003x^2 - - .000008x^3$ was found to best fit the data. When the learning period was divided, the equations for the first and second halves were found to be $y = 3.633 - .048x$ and $y = 2.446 - .107x$ respectively. The P/2 of the difference between their means was found to be 0.00, which is evidence for the existence of a true difference, or that learning had taken place. When the rates of learning in the two halves of the period were compared, it was observed that that of the second half was over twice as great as that of the first. Since the P/2 of the difference between these means was calculated to be 0.00, we may infer that this was in no way due to chance.

Effects of the different types of motivation

The relative efficiency of the different types of motivation was studied with respect to the average number of errors made by each group at the end of the learning period. As previously stated, the scores of the individuals who had mastered the maze before trial 20 had been dropped from the records before the results were tabulated. Since there was a possibility that a score made on the final trial might be affected by chance deviation, the mean of the last five trials (trials 26, 27, 28, 29, and 30) for each group was substituted as a basis for intercomparison. The groups were then ranked in order of their elimination of errors as follows:

Group	*Mean No. Errors*
IV (NR–R)	1.675
II (MR)	1.675
V (VR–R)	1.875
III (VR)	2.325
I (NR)	2.625

It is evident from the above that the material reward group and the no reward-reward group showed the greatest elimination of errors. Since the difference between the final scores of the verbal reward-reward group and these two was so small, it was necessary to determine whether this difference was a true difference or merely due to chance. The D/sigma D of the difference between the average of the material reward group and that of the verbal reward-reward group was therefore calculated and found to be 1.226 which may be interpreted as meaning that there are only 88 chances out of 100 that the difference obtained was a true one. Since a D/sigma D of 3 or greater is necessary for absolute reliability, we may ascribe this difference to chance (14, pp. 128–133). The D/sigma D of the difference between the final score of the no reward-reward and the verbal reward-reward groups was found to be 1.369, again indicating a chance difference. Material reward, no reward-reward, and verbal reward-reward may therefore be ranked as equally effective in reduction of errors.

The verbal reward group ranks next with a final average score of 2.325. To determine the reliability of the difference between this and the score of each of the preceding groups, the D/sigma D's were calculated as follows:

Groups	*D/sigma D between Final Scores*
III (VR) and II (MR)	3.110 (100 chances out of 100 for a true difference)
III (VR) and IV (NR–R)	3.316 (" " " " " " " " ")
III (VR) and V (VR–R)	2.760 (99.7 " " " " " " " ")

We may say, then, that the effect of verbal reward is reliably less than any kind of material reward.

The no reward group ranked lowest in the reduction of number of errors made. Since the D/sigma D between its final score and that of the verbal reward group was found to be 1.612 (94 chances out of 100 for a significant difference), we may interpret this to mean that there are strong indications that verbal reward as an incentive is more effective than no reward, although the difference found is not absolutely reliable.

The material reward groups (MR, NR–R, and the VR–R) therefore were most proficient in learning the maze; the verbal reward group came next; and, the no-reward group, last.

Effects of shift in motivation

Blodgett (3) and Tolman and Honzik (25) in their experiments found that rats run in a maze without food made little improvement in their learning scores, but that upon introduction of reward they almost at once showed a performance equalling that of the control group which had been receiving the reward from the beginning of the learning period. They assert that this sudden drop in the error curve when reward is introduced is a manifestation of "latent learning".

A direct comparison of their results with those of the present experiment cannot be made inasmuch as the no-reward conditions in the animal experiments could not be duplicated with human subjects. In the first place, Tolman's rats under no-reward conditions had no goal, while the human subjects, by the very nature of the task and the instructions given, knew what the goal was and when it was reached. In the second place, the rats possessed no knowledge of results whereas the human subjects could tell, though but approximately, from the number of blind alleys into which they had strayed, how many errors they had made and whether or not they were making any improvement. Tolman's no-reward group, therefore, showed no evidence of learning while the no-reward group in the present experiment showed a definite reduction in the number of errors made.

It was decided that the best method of determining whether a change to a new reward had an immediate or delayed effect upon learning was by a comparison of the drop in errors which one would naturally expect to occur (from an observation of the data up to this point) with the actual drop in errors experienced after the introduction of the new reward. If the effect were immediate, it should be shown within the following two or three trials. Consequently, the period preceding the change in motivation (trials 13, 14, 15) was compared with that immediately following (trials 16, 17, 18). By calculating the last three points on the trend line for the first half of the learning period of each group, it was possible to compute the amount of drop from trials 13 to 15. If the change to a new reward had no immediate effect upon the learning curve, then we could expect that the actual drop in errors from trials 16 to 18 would be approximately the same as that for the preceding trials. With this in mind the following calculations were made:

Group	Motivation	Trend Line Drop Trials 13–15	Actual Drop Trials 16–18	Diff. Between Expected and Actual Drop
I	No reward	–.138	0.00	.138
II	Material reward	–.113	+0.11	.223
III	Verbal reward	–.184	–0.50	.316
IV	No reward-reward	–.026	–0.75	.724
V	Verbal reward-reward	–.118	–0.30	.182

From the above, the following observations may be made: first, that the material reward and the no-reward groups do not make the reduction in errors which one would expect from a study of the drop in the trend line of the preceding trials; secondly, that the verbal reward and the verbal reward-reward groups make a slightly greater reduction in errors than would be expected; and thirdly, that the no reward-reward group makes a reduction not only much greater than would be expected from the previous trials but also very much greater than that of the control group which had been receiving a material reward throughout the learning period.

It is evident from the above, therefore, that a shift in motivation had an immediate effect upon Group IV only. We may interpret the sudden drop in the learning curve of this group after the introduction of a material reward in either of two ways: first, that some latent learning had been going on under no-reward conditions which had not been manifested until the change to a new reward; or secondly, that the introduction of the reward served as a very effective spur to the children's efforts with the result that a great elimination of errors ensued almost immediately.

SECTION III: SUMMARY OF RESULTS AND THEIR INTERPRETATION

1. When the data of each group and the learning curves are inspected, it is immediately evident that actual learning, by which is meant the reduction of the number of errors made, took place in each of the five groups. Since this was true of the non-rewarded group as well as of the rewarded groups, it is obvious that knowledge of results and of the goal to be reached were enough to bring about learning without the addition of any further incentive. Of course, this finding is not new. Arps (1) in 1917 demonstrated that there was a greater efficiency in ergographic work, both in terms of the quantity of the work accomplished and of the rate of working, when the subject knew the results of his performance than when knowledge was withheld. Johanson (18), Crawley (8), and Ross (22) have all added to the evidence for the greater efficacy of learn-

ing with knowledge of results as compared with its absence. In the present experiment, although the children were never told the results of a trial made, they themselves were more or less able to judge how many errors had been made from the number of blind alleys into which they strayed. They, consequently, possessed some information as to their progress and it was this that probably helped to bring learning about.

2. When the types of motivation were ranked in their order of efficiency in the elimination of errors, they were found to be as follows:

> (1) Material reward, no reward-reward, and verbal reward-reward. The first two groups ranked the same in the final trials in the learning period, and, since no significant difference was found between their results and those of the verbal reward-reward group, it was decided that the three were equal in their effectiveness as motivators.
>
> (2) Verbal reward ranked next in its elimination of errors, as indicated not only by the absolute amount of errors made at the end of the learning period, but also by the fact that significant differences were found between its data and those of the above-mentioned groups (material reward, no reward-reward, and verbal reward-reward).
>
> (3) No reward is the least effective in reduction of errors. The average number of errors made by the group was greater than that made by the verbal reward group. The difference between them was not, however, found to be completely reliable inasmuch as the D/sigma D was 1.612.

One gathers, therefore, that although knowledge of results and the goal to be reached are effective in bringing about learning, as in the no-reward group, nevertheless the addition of a verbal reward is more effective, while the addition of a material reward is of even greater effectiveness.

3. The groups in which a material reward was introduced only in the second half of the learning period (the no reward-reward and the verbal reward-reward groups) learned just as well by the end of the learning period as did the material reward group which had been receiving the reward from the very beginning. When the last five trials of each of these groups were averaged, it was found that no reliable difference existed between the groups, as indicated by the D/sigma D of the difference between the means. Although the material reward group at the end of 30 trials had actually re-

ceived twice as many pennies as the no reward-reward and the verbal reward-reward groups, the group, nevertheless, made no greater reduction in errors. This would seem to indicate that it is not so much the number of times the reward is received as it is its temporal position, that is important in its use as an incentive. The question of whether or not the drop in the error curve in Group IV may be ascribed to latent learning will be discussed later on in this section, in division 6.

4. The administering of a standardized verbal reward seems to lose its effectiveness as an incentive with its continuation over the learning period. The trend line of the verbal reward group showed at first a fairly rapid drop, but after the tenth trial this tended to become less and less marked. When the trend lines for the halves of the learning period were compared, it was noticed that the rate of learning of that of the second half was only half as great as that of the former. This again points to the fact that verbal reward seems to have a diminishing effect on the learning of the maze.

5. In the present investigation a shift to a new reward was found to have an immediate effect upon the learning of the no reward-reward group and a delayed effect upon the verbal reward-reward group. This is evidenced by the following facts: first, that the former group made a vastly greater reduction in errors after the introduction of a new reward than was to be expected if the change had had no effect; secondly, that the verbal reward-reward group made only a slightly greater reduction than would be expected and that this reduction was not as great as that made by Group III which received verbal reward throughout the period. The evidence therefore as to the effects of a shift in motivation is not conclusive and further interpretation must wait until more work has been done.

6. Since Tolman's group of rats showed little improvement in their learning scores under no-reward conditions while the group of children in the present experiment did show signs of learning under no-reward conditions, a direct comparison of the two experiments is out of the question. As has been pointed out, some learning was shown to exist under our no-reward conditions. If there were, in addition to this, some learning which was not shown due to the conditions of motivation, this should have been manifested when the material reward was introduced by a sudden drop in the error curve greater than that of the control group which had been receiving

throughout the learning period the same material reward. This phenomenon was found in the case of the no reward-reward group but not in the case of the verbal reward-reward group. The evidence is not conclusive for either alternative. We may say that this sudden drop in the learning curve of Group IV after the introduction of a material reward can be interpreted in two ways: first, as a result of "latent learning"; or secondly, as the result of a much greater spur to the subject's efforts, brought about by the change in motivation.

CHAPTER VI

EXPERIMENT TWO

In the first experiment, an attempt was made to study the effects of a shift in motivation upon the learning of a raised finger maze. As with the animal experiments, reward, when administered, was given at the end of every trial and was not associated with any ''rightness'' of response (by which I mean decrease in errors made). The following questions then arose: What would be the effect upon learning if the subject knew that reward was dependent upon improvement? And again, what would be the effect on learning of the promise of an exceptionally large reward for a perfect performance? What would be the effects of a shift in motivation under these conditions?

The specific problem to be investigated, therefore, was the effect of motivation-shifting (from no reward and from verbal reward to material reward) on the learning of a Multiple-U maze, finger type, when reward was contingent on improvement in learning.

SECTION I: SUBJECTS, PROCEDURE, TREATMENT OF DATA

Subjects

Since there was difficulty in finding in the public school system another group of subjects of the same intelligence level as those of the first experiment, it was decided to use children of the same chronological age but of average IQ. The National Intelligence Test (15) was therefore administered to all the children in the fourth, fifth, and sixth grades of P. S. 96, New York City. The subjects like those of the preceding group came from homes of the lower middle class. Sixty children, therefore, with a CA from 9 years, 2 mos. to 10 years, 1 mo., inclusive, and with IQ's ranging from 88 through 111, were divided into six equal groups equated according to CA and MA.

Since the range in chronological age was confined to approximately one year, but that of mental age was in some instances over twice as great, it was necessary to determine whether or not there were significant differences in the mental ages of the groups. The D/sigma D's between the means of the MA's of the groups were therefore computed.

TABLE 6

Showing the Average, the Range, and the Sigmas of the Distribution of the Chronological and Mental Ages of Each of the Six Groups

Group	*CA*			*MA*		
	Average	*Sigma*	*Range*	*Average*	*Sigma*	*Range*
VI	9–8	.193	9–2 to 10– 0	9–9	.707	8–8 to 10–10
VII	9–7	.207	9–4 to 9–11	9–6	.698	8–5 to 10– 8
VIII	9–5	.206	9–3 to 10– 1	9–4	.651	8–4 to 10– 5
IX	9–8	.195	9–3 to 9–10	9–7	.689	8–5 to 10– 7
X	9–8	.229	9–3 to 10– 0	9–9	.593	8–9 to 10–10
XI	9–8	.331	9–4 to 10– 1	9–6	.630	8–9 to 10– 7

As may be seen from the above table, there was no reliable difference between the mental ages of the groups.

TABLE 7

Showing the Chances of a True Difference Greater Than Zero Existing Between the Means of the Mental Ages of the Six Groups

Groups	*D/sigma D*	*Chances in 100*
VI and VII	0.525	70
VI and VIII	1.380	91
VI and IX	0.270	60
VI and X	0.000	50
VI and XI	0.838	80
VII and VIII	0.819	79
VII and IX	0.264	60
VII and X	0.568	71
VII and XI	0.275	61
VIII and IX	1.117	86
VIII and X	1.505	93
VIII and XI	0.585	72
IX and X	0.293	61
IX and XI	0.564	71
X and XI	0.915	82

Motivation Procedure

The method of administering motivation in each of the groups may be briefly described as follows:

Group VI—*No reward (NR) group*—30 trials no reward. Procedure as described on pp. 15 and 16.

Group VII—*Material reward (MR) group*—30 trials. Procedure like that of no reward group except that after the preliminary trial, the child was given a penny and told, "Now, every time you do better than the time before; that is, every time you make less mistakes than you did on the trial before, I'm going to give you a penny for you to keep''. A glass dish was placed at the child's side into which he dropped the penny as it was given him. This procedure was followed for the remainder of the learning period.

Group VIII—*Verbal reward* (*VR*) *group*—30 trials. Procedure like that of no-reward group except that after the preliminary trial the child was given a verbal reward (E said ''Good! Let me see if you can make even *less* mistakes next time''). After this the verbal reward was given only when he had actually made less mistakes than on the preceding trial. The verbal rewards used in Experiment I (p. 19) were rotated, as in that experiment.

Group IX—*No reward-reward* (*NR-R*) *group*—15 trials no-reward, 15 trials material reward. Procedure at first same as that of no-reward group. After the fifteenth trial the child was given a penny and told, ''Now, every time you do better than the time before; that is, every time you make less mistakes than you did on the trial before, I'm going to give you a penny for you to keep''. This procedure, like that of Group VII, was then adhered to for the remainder of the trials.

Group X—*Verbal reward-reward* (*VR-R*) *group*—15 trials verbal reward, 15 trials material reward. For the first half of the learning period the child was given a verbal reward every time he made less mistakes than on the preceding trial (Procedure follows that of Group VIII). After the fifteenth trial the child was given a penny and told that he would receive another one every time he did better than on the trial before (Procedure that of Group VII). This was continued for the remainder of the trials.

Group XI—*Maximum material reward* (*MMR*) *group*—At the end of the preliminary trial the child was told, ''Now, every time you go through the maze without making *one* mistake, I'm going to give you twenty-five cents. Do you understand? Every time you go through the maze without making any mistakes. I'm going to give you twenty-five cents for you to keep.'' Whenever the child performed the task perfectly he was given the stated reward. The learning period as in the other groups consisted of thirty trials.

Scoring:

The scoring was the same as that in Experiment I, pp. 19–20. The number of cases and the points at which they reached the criterion of mastery, two successive errorless trials, are as follows:

Group	No. Individuals Mastering Maze
VI	1 (at trial 25)
VII	1 (at trial 27)
VIII	1 (at trial 24)
IX	1 (at trial 27)
X	1 (at trial 29)
XI	2 (1 at trial 25, 1 at trial 27)

Treatment of Data

The average number of errors made by each of the six groups for each of the thirty trials constituting the learning period was tabulated (see table 8, p. 39) and the data for each group plotted (see figures 6, 7, 8, 9, 10, and 11 on pp. 38, 39, 40, and 41, respectively). Although the curves of average error may be compared through observation, it was decided to calculate the lines of trend so that their similarities and differences might be more clearly seen.

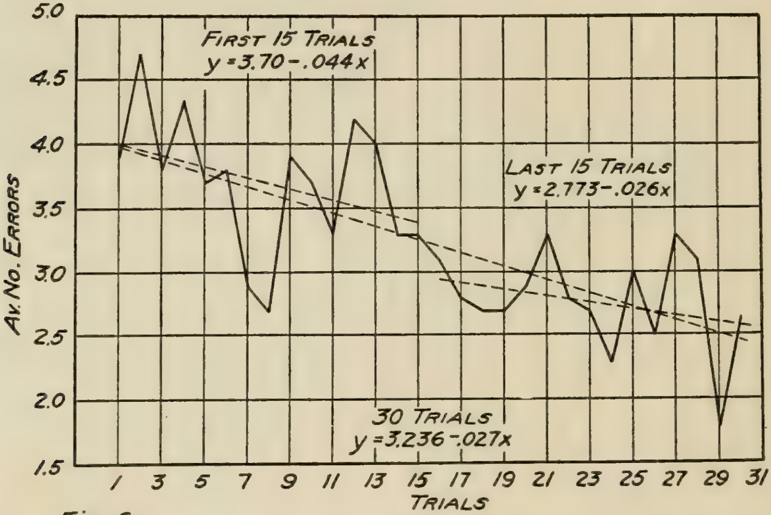

Fig. 6

GROUP VI—No Reward Group: showing the average number of errors made by the group for each of the thirty trials; the trend line for the learning period as a whole; and, the trend lines for the first and second halves of the period.

In two cases, the trend lines were straight lines (see figs. 6 and 8, pp. 38 and 40, respectively); and in the other four, second degree equations (see figs. 7, 9, 10, and 11, pp. 39, 40, and 41, respectively). That the shift in motivation occurring in these two groups might be compared with equal periods of shift in the other groups,

TABLE 8

Showing the Average Number of Errors Made by Each of the Six Groups for Each of the Thirty Trials in the Learning Period

Trial	*Av. No. of Errors Made*					
	Group VI	*Group VII*	*Group VIII*	*Group IX*	*Group X*	*Group XI*
1	3.9	2.8	4.5	4.7	4.2	4.7
2	4.7	3.8	3.9	3.9	3.6	4.7
3	3.8	3.5	3.3	3.7	4.1	3.8
4	4.3	3.7	3.5	3.2	3.9	3.9
5	3.7	3.3	3.5	3.3	3.2	4.0
6	3.8	3.5	2.8	3.3	4.1	4.0
7	2.9	2.9	3.2	3.4	3.8	3.7
8	2.7	3.4	3.6	3.7	3.0	4.5
9	3.9	3.6	3.9	4.1	3.3	4.1
10	3.7	3.2	2.7	3.3	3.4	3.6
11	3.3	3.1	3.1	3.7	4.0	4.2
12	4.2	3.2	3.4	3.9	3.9	3.7
13	4.0	3.3	3.9	3.7	3.3	3.5
14	3.3	3.1	3.1	3.4	3.1	3.9
15	3.3	3.1	2.6	2.8	3.5	2.3
16	3.1	2.9	2.5	2.9	3.3	2.7
17	2.8	3.1	3.6	3.5	2.9	2.7
18	2.7	2.5	3.4	3.0	3.2	2.4
19	2.7	2.6	2.9	3.0	2.4	2.4
20	2.9	2.5	3.2	3.0	2.8	2.1
21	3.3	2.7	3.4	2.7	3.0	3.0
22	2.8	2.5	3.0	2.9	2.6	3.4
23	2.7	2.3	2.5	2.8	2.2	2.9
24	2.3	2.0	2.7	2.8	2.5	1.7
25	3.0	2.1	2.4	2.6	2.4	1.8
26	2.5	2.2	2.7	2.3	2.9	2.2
27	3.3	2.4	2.4	1.9	1.5	1.9
28	3.1	1.8	2.7	2.0	1.9	1.7
29	1.8	2.2	3.1	1.4	1.8	1.2
30	2.6	2.3	2.1	1.3	1.5	0.6

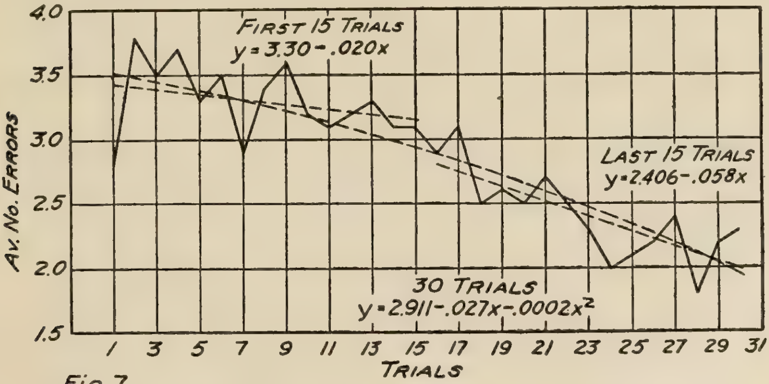

Fig. 7

Group VII—Material Reward Group: showing the average number of errors made by the group for each of the thirty trials; the trend line for the learning period as a whole; and, the trend lines for the first and second halves of the learning period.

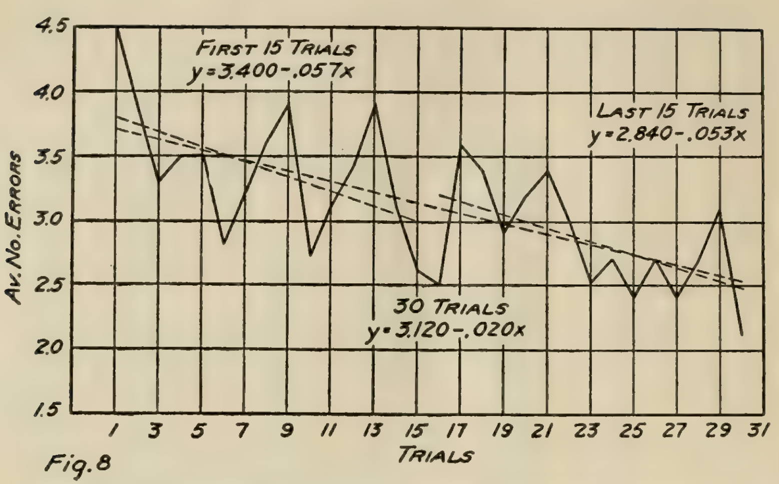

Fig. 8

Group VIII—Verbal Reward Group: showing the average number of errors made by the group for each of the thirty trials; the trend line for the learning period as a whole; and, the trend lines for the first and second halves of the learning period.

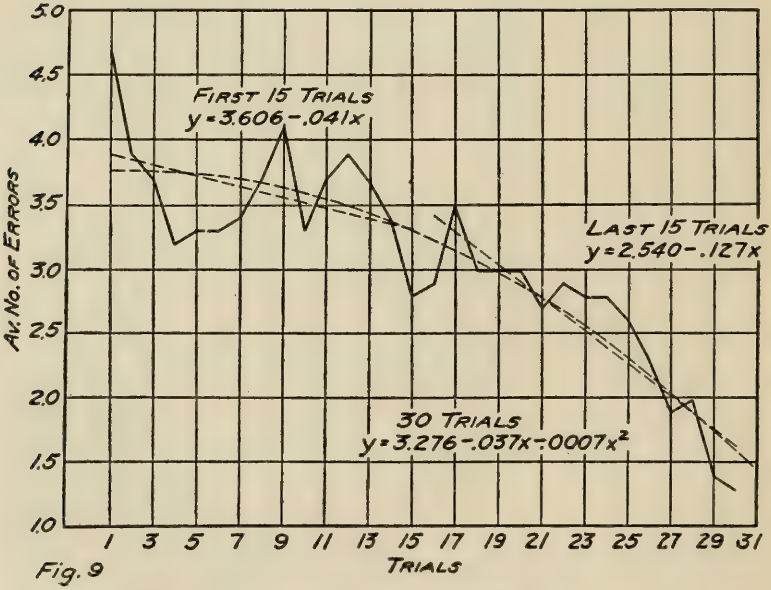

Fig. 9

Group IX—No Reward-Reward Group: showing the average number of errors made by the group for each of the thirty trials; the trend line for the learning period as a whole; and, the trend lines for the first and second halves of the learning period.

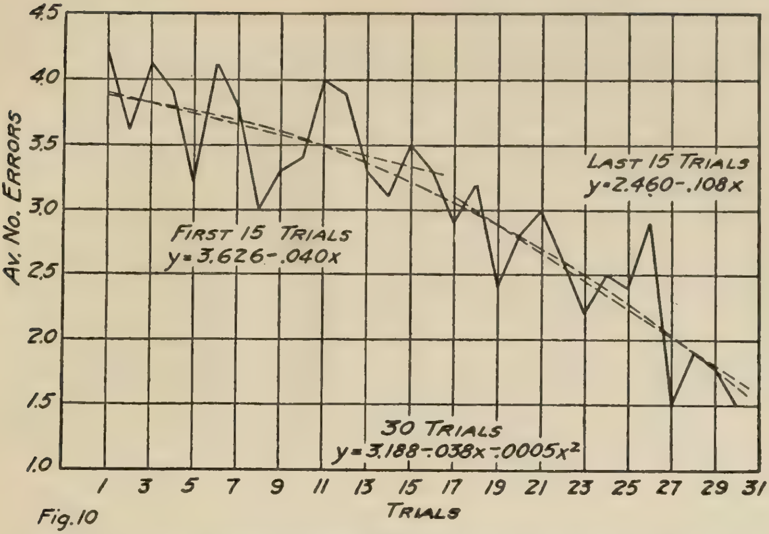

Fig. 10

Group X—Verbal Reward-Reward Group: showing the average number of errors made by the group for each of the thirty trials; the trend line for the learning period as a whole; and, the trend lines for the first and second halves of the learning period.

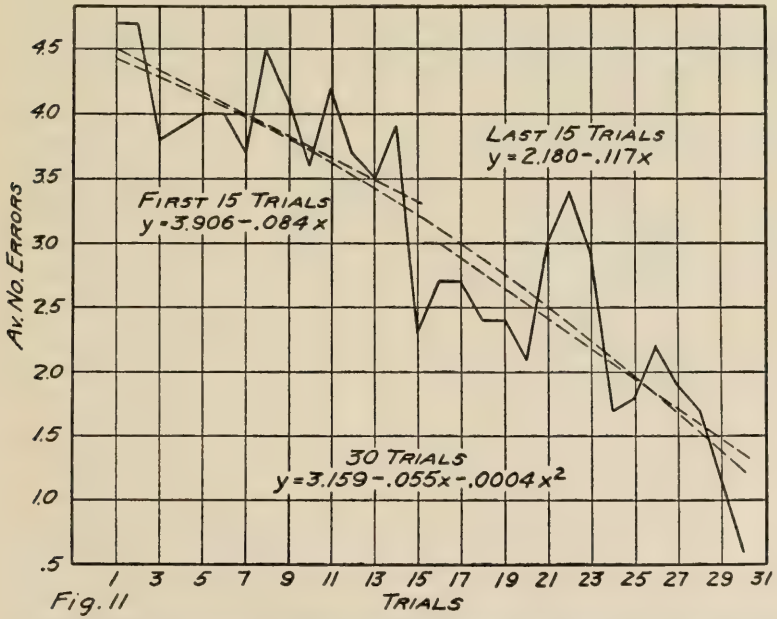

Fig. 11

Group XI—Maximum Material Reward Group: showing the average number of errors made by the group for each of the thirty trials; the trend line for the learning period as a whole; and, the trend lines for the first and second halves of the learning period.

trend lines were calculated for the first and second halves of the learning period (for trials 1–15 and for trials 16–30) of every group. (See table 9, p. 42.) As in the first experiment, the P/2 of the difference between the means and between the slopes of the two halves of the period were calculated (see table 10, p. 42) so that the 2 parts of a learning period might be compared and also their relative rates.

TABLE 9

SHOWING THE TREND LINES OF EACH OF THE SIX GROUPS: THAT IS, FOR THE WHOLE LEARNING PERIOD, FOR THE FIRST HALF OF THE PERIOD (TRIALS 1 THRU 15) AND FOR THE SECOND HALF OF THE LEARNING PERIOD (TRIALS 16 THRU 30)

Group	*Whole learning period*	*Trials 1 thru 15*	*Trials 16 thru 30*
VI (NR)	$y = 3.230 - .027x$	$y = 3.70 - .044x$	$y = 2.773 - .026x$
VII (MR)	$y = 2.911 - .027x - .0002x^2$	$y = 3.30 - .020x$	$y = 2.406 - .058x$
VIII (VR)	$y = 3.120 -. 020x$	$y = 3.40 - .057x$	$y = 2.840 - .053x$
IX (NR–R)	$y = 3.276 - .037x - .0007x^2$	$y = 3.606 - .041x$	$y = 2.540 - .127x$
X (VR–R)	$y = 3.188 - .038x - .0005x^2$	$y = 3.626 - .040x$	$y = 2.460 - .108x$
XI (MMR)	$y = 3.159 - .055x - .0004x^2$	$y = 3.906 - .084x$	$y = 2.180 - .117x$

TABLE 10

SHOWING THE P/2 OF THE DIFFERENCE BETWEEN THE MEANS OF THE TWO HALVES OF THE LEARNING PERIOD OF EACH GROUP AND THE P/2 OF THE DIFFERENCE BETWEEN THE RATES OF LEARNING (AS INDICATED BY THE SLOPE OF THE TREND LINE) OF THE TWO HALVES OF THE LEARNING PERIOD OF EACH GROUP

Group	*P/2 of diff. Bet. Means*	*P/2 of diff. Bet. Slopes*
VI (NR)	0.00	0.000
VII (MR)	0.00	0.090
VIII (VR)	0.00	0.450
IX (NR–R)	0.00	0.035
X (VR–R)	0.00	0.075
XI (MMR)	0.00	0.280

SECTION II: DISCUSSION OF RESULTS

Group Results

1. *No reward group*

The raw data of this group show a gradual downward trend, best fitted by the straight line equation, $y = 3.236 - .027x$. When the learning period was divided into two parts, it was found that the trend line for trials 1 through 15 was $y = 3.70 - .044x$ and for trials 16 through 30, $y = 2.773 - .026x$. To find out whether or not there was a reliable difference between the mean of the number of errors made in the first half and that of the second, the P/2 of their difference was computed and found to be 0.00. We may interpret this to mean that there is no possible chance that the difference obtained can be due to sampling error. Thus it can be seen that there is a significant reduction in errors from the first to the second half of the learning period, and that this reduction indicates that learning has taken place. From the trend lines for the two halves, it is evident that the slope of the first is almost twice that of the second. To find whether or not there was a true difference between them, the P/2 was calculated and found to be 0.00. From this we may conclude that the rate of learning in the first half of the period is greater than that of the second, and that this difference is not due to chance.

2. *Material reward group*

The slope of the data is fairly gradual at first but increases with the progression of the period. There is a rather steep drop in the error curve after the seventeenth trial. The data of this group are best fitted by the second degree equation, $y = 2.911 - .027x - .0002x^2$. The equations for the first and second halves of the learning period are $y = 3.30 - .020x$ and $y = 2.406 - .058x$, respectively. A P/2 of 0.00 between their two means indicates that this difference cannot be due to chance, but that actual learning has taken place. When the slopes of the two trend lines are compared, it may be seen that that of the second half is over twice that of the first. Since the P/2 of their difference is .09, we have an indication that the speed of learning in the second half of the experiment is greater than that of the first half, although we cannot definitely state that is so.

3. *Verbal reward group*

Upon observation of the data of this group, it is evident that its most noticeable feature is the unevenness of the error curve. It is best fitted by the straight line equation, $y = 3.120 - .020x$. When the learning period was divided, the trend lines for the first and second halves were $y = 3.40 - .057x$ and $y = 2.84 - .053x$. A P/2 of the difference between their means of average error was found to be 0.00, indicating that learning had taken place. From an inspection of the trend lines, it is fairly obvious that the rate of learning in both halves is much the same. This is borne out by the fact that the P/2 of the difference between their slope is .45; that is, there are 45 chances out of 100 that the slight difference existent is due to sampling error.

4. *No reward-reward group*

In this group the descent of the error curve is not very great until after the fifteenth trial, at which point the material reward had been introduced. The data are best fitted by a second degree equation, $y = 3.276 - .037x - .0007x^2$. The trend lines for the two halves of the period are $y = 3.606 - .041x$ and $y = 2.54 - .127x$. When the P/2 of the difference between their two means was calculated, it was found to be 0.00 which substantiates the results of the observation, that the decrease in the average number of errors made in the second half as compared with that in the first half, was a true decrease and not due to chance. In addition, it may be observed that the slope of the trend line of the second half is three times as great as that of the first. This may be regarded as reliable, since its P/2 is .035. In other words, there is a reliable increase in rate of learning after the introduction of the material reward.

5. *Verbal reward-reward group*

In this group the data at first show a very gradual slope; with the introduction of material reward, however, the reduction in the number of errors made is more pronounced. The equation whose trend line best fits these data is a second degree in which $y = 3.188 - .038x - .0005x^2$. The trend lines for the first and second half of the learning period were found to be $y = 3.626 - .040x$ and $y = 2.46 - .108x$. To find out whether or not there is a true difference between their two means, the P/2 was computed and found to be 0.00, indicating that the difference in the amount of errors made in the two halves is a reliable one. When the speed of learning of the two halves was considered (as indicated by the slope of the trend line) the rate of the second was found to be over twice that of the first. It cannot be asserted that this difference is reliable, however, since its P/2 was found to be .075. Nevertheless, one may say with some justification that a strong indication of this does exist.

6. *Maximum material reward group*

Of all the groups of data, this shows the sharpest descent in the error curve, the steeper part of the drop occurring between the fourteenth and twentieth trials. The data as a whole are best fitted by a second degree equation, $y = 3.159 - .055x - .0004x^2$. The trend lines for the two halves of the learning period were found to be $y = 3.906 - .084x$ and $y = 2.180 - .117x$. When the P/2 of the difference between the means of the two halves of the period was computed, it was found to be 0.00, which result, from an observation of the data, was to be expected. From an inspection of the slopes of the trend lines, it is evident that there is an increase in the rate of learning in the second half. The P/2 of the difference between the slopes was found to be .28, which would indicate however that this increase was not a reliable one.

Results of the Different Types of Motivation

The effects of motivation on the learning of the maze were studied by averaging the last five trials in each group (trials 26, 27, 28, 29, 30) and tabulating the average number of errors made by each. They were then ranked in their order of elimination of errors:

Group	*Av. No. Errors*
XI (MMR)	1.600
IX (NR–R)	1.820
X (VR–R)	1.975
VII (MR)	2.260
VIII (VR)	2.620
VI (NR)	2.950

From the above it is evident that the maximum material reward group showed the greatest learning. The no reward-reward and the verbal reward-reward groups came next with a slight difference in favor of the former. To determine whether or not this difference was significant, the D/sigma D was computed and found to be .567, or only 71 chances in 100 of the difference being reliable. When the reliability of the differences between the means of these and the maximum material reward group was calculated, it was found that the D/sigma D between the NR–R and MMR was .714; and between the VR–R and the MMR, 1.150. We may therefore conclude that these three groups were approximately equal in effectiveness as motivators.

The material reward group, ranking fourth in absolute position, had a score significantly greater than those of the preceding groups. The D/sigma D between the MR and the NR–R groups was found to be 2.222. In other words, there are 99 chances out of 100 that the difference is significant. The D/sigma D between the MR and the VR–R groups was found to be 1.610, or 94 chances out of 100 for the difference being significant.

The verbal reward group ranked fifth in the above tabulation. The D/sigma D of 2.142 between it and the material reward group is a strong indication that verbal reward is less effective as an incentive. Although the no-reward group ranked lowest in elimination of errors, when its mean was compared with that of the verbal reward group, it was found that there was no reliable difference between the groups (the D/sigma D equals 1.170).

We may conclude that the verbal reward and the no-reward conditions were the least effective as reducers of errors; that the material reward was more effective; and, that a very large material reward and that a shift from no-reward or verbal reward to material reward were even more effective.

Effects of Shifts in Motivation

To determine whether a shift in motivation had an immediate or delayed effect upon learning, the drop in errors which one would naturally expect to occur (from an observation of the data up to this point) was compared with the actual drop in errors experienced after the introduction of the new reward. If the effect of the new motivation were immediate, it should be manifested within the next two or three trials. The period, therefore, preceding the change in motivation (trials 13 to 15) was compared with that immediately following (trials 16 to 18). By calculating the last three points on the trend line for the first half of the learning period of each group, it was possible to determine the amount of drop from trials 13 to 15. If the change to a new reward had no immediate effect upon learning, then it would be expected that the actual drop in errors from trials 16 to 18 would be approximately the same as that from 13 to 15. With this in mind, the following results were therefore calculated:

Group	*Motivation*	*Trend Line Drop Trials 13 to 15*	*Actual Drop Trials 16 to 18*	*Diff. Between Expected and Actual Drop*
VI	No reward	–.088	–.40	.312
VII	Material reward	–.040	–.40	.360
VIII	Verbal reward	–.114	+.90	1.014
IX	No reward-reward	–.082	+.10	.182
X	Verbal reward-reward	–.080	–.10	.020
XI	Maximum material reward	–.168	–.30	.132

From the above, the following observations may be made: first, that the verbal reward group makes a very much less reduction in errors from trials 16 to 18 than would be expected from the drop in the trend line from trials 13 to 15; secondly, that the no reward-reward and the verbal reward-reward groups make approximately the same reduction as before; and thirdly, that the no-reward, the material reward, and the maximum material reward groups make larger reductions than expected.

It is evident, therefore, that the effect upon learning of a change to a new reward was not immediate. Not only was the drop in errors after the change approximately the same as before but also the control groups (with the exception of Group VIII) made a greater elimination of errors than did the experimental. Since we did not find a sudden drop in the learning curve of the motivation-shifting groups, we may conclude that no latent learning had been going on under the no reward conditions.

SECTION III: SUMMARY OF RESULTS AND THEIR INTERPRETATION

1. When the data of each group and their learning curves are inspected, it is immediately evident that all groups show an actual reduction in the number of errors made over the course of the learning period. Since this was true of the no-reward group as well as of the rewarded groups, it is probably true that knowledge of results and the goal to be reached is enough to bring about learning without any additional motivation.

2. When the types of motivation were ranked in their order of efficiency in the reduction of errors, they were found to stand as follows:

   (1) Maximum material reward, no reward-reward, and material reward. Although the former showed the greatest absolute decrease in errors, nevertheless the differences between its mean and those of the other 2 groups were not found to be reliable. These may therefore be said to have approximately the same effectiveness as motivators.

   (2) Material reward ranked next in its effectiveness as a reward. Fairly reliable differences were found between it and the groups in the above classification.

   (3) Verbal reward and no reward were about equally effective in bringing about learning. Although the number of errors made by the former was slightly less than that of the latter, the difference was not reliable. One may gather,

therefore, that no-reward and verbal reward were approximately equal in bringing about learning; that a material reward was more effective; and that motivation-shifting and a very large reward were even more effective.

3. The groups in which the material reward was introduced in the second half of the learning period (the no reward-reward and the verbal reward-reward groups) did just as well, if not a little better, than the material reward group which had been receiving the incentive since the beginning of the learning period. When the last five trials of the learning period in each group were averaged, it was found that there was a reliable difference in favor of the motivation-shifting groups. Although the material reward group actually received reward more often than the other two groups, it was nevertheless not as efficient in learning. This would indicate that it is not so much the number of times that a reward is administered, as it is its temporal position, that is important in its use as an incentive. The question of latent learning will be discussed in division 6.

4. The administering of a standardized verbal reward, even though given only when actual improvement is made, soon loses its effectiveness as a motivator of learning. The trend line of Group VIII at first showed a fairly rapid drop; but since after the first few trials it became much less marked, this would seem to indicate that a standardized verbal reward, administered only when actual improvement was made, amounts simply to furnishing a knowledge of results.

5. In the present experiment, a shift to a new reward was found to have a delayed effect on the learning curve. This is borne out by the fact that the decrease in the number of errors made after the introduction of a different incentive (in the experimental groups) was approximately the same as that made before the change.

6. Since my no-reward group showed evidences of learning, this experiment, like the first, cannot be directly compared with Tolman's. As has been pointed out before, some learning occurred even under no-reward conditions. If there were, in addition to this, some which had not been shown due to the conditions of motivation, it should have been manifested upon the introduction of a material reward by a sudden drop in the error curve. Since no evidence of the existence of such a phenomenon was found, we need not assume that "latent learning" had occurred.

CHAPTER VII

A COMPARISON OF EXPERIMENTS ONE AND TWO

The main points of divergence between the two experiments, difference in general intelligence level and in reward administration, have an important bearing on the interpretation of the results.

In both studies the children were of the same chronological age (from 9–2 to 10–1) with variations in relative brightness. In the second experiment the subjects were of average intelligence, with IQ's ranging from 88 to 111; in the first experiment they were of superior intelligence, with IQ's from 100 to 129. An overlapping of 11 points therefore exists between the groups. In the second experiment, reward was definitely associated with improvement since it was only given when the subject showed a decrease in errors made. In the first experiment, reward was administered at the end of every trial regardless of the kind of performance made.

To determine whether the above differences had any effect on the results, the two experiments were compared with respect to no-reward, material reward, verbal reward, and change of reward. The D/sigma D's between the means of the last five trials of the comparable groups have been tabulated (see table 11, p. 49).

TABLE 11

Groups	*Motivation*	*Av. of Last 5 Trials*				*D/sigma D*
I and VI	No reward	I	2.625	VI	2.950	1.217
II and VII	Material reward	II	1.675	VII	2.260	3.401
III and VIII	Verbal reward	III	2.325	VIII	2.620	1.432
IV and IX	No reward-reward	IV	1.675	IX	1.820	0.627
V and X	Verbal reward-reward	V	1.875	X	1.975	0.463

1. In both experiments the no reward groups worked under identical conditions, the only difference being in the relative intelligence of the subjects themselves. A D/sigma D of 1.217 between the means of their final trials indicates that there is no true difference between them. We may say, therefore, that knowledge of the results and the goal to be reached had approximately the same effect on the two groups despite the intellectual difference.

2. When the results of verbal reward are compared, it is evident that here again the slight difference existent is unreliable since the D/sigma D of the final trials is 1.432. Despite the presence of a

lower level of intelligence, the group in which praise was associated with improvement did just as well as the group of a higher intelligence in which this relationship did not obtain.

3. When the final results of the two material reward groups (II and VII) are compared, it is evident, from the fact that the D/sigma D between their means is 3.401, that a reliable difference exists between them. The effect of reward dependent upon improvement with a group of average intelligence does not seem to be as great as that of reward, administered at every trial, with a group of superior intelligence.

4. The effects of motivation shifting seem to be the same in both experiments in spite of the fact that in the second the subjects were of a lower level of intelligence and reward was contingent upon improvement. A D/sigma D of .627 between the final scores of the no reward-reward groups and one of .463 between the verbal reward-reward groups indicate the lack of any reliable difference between them. There are indications therefore that the number of times a reward is administered is not as important as its temporal position.

5. When the learning curves of the 11 groups are compared, it is very obvious that the maximum material reward group showed the most rapid elimination in number of errors made, although the subjects were of a lower intelligence level than any of those used in Experiment I. The promise of a very large reward for complete learning seems to be more effective than any other type of motivation (although the difference found is not completely reliable).

6. In both experiments, with the exception of Group IV, it was found that a change of reward had a delayed effect on the learning curve.

7. Since in both experiments the no-reward groups showed evidence of learning, the present study cannot be directly compared with that of Tolman's in which no-reward was found to have no effect on improvement in the learning scores of his animals. If there had been any additional learning (besides that already found in the no-reward group) which had not been manifested due to lack of adequate motivation, it should have been brought out when the material reward was introduced. Since with the exception of Group IV, no sudden drop was found in the learning curve after the introduction of a material reward, it is unnecessary to assume the presence of latent learning. Even the sudden drop in the error curve of Group IV may be interpreted as being due to a spurring on to increased efforts, brought about by the new reward.

CHAPTER VIII

SUMMARY AND GENERAL CONCLUSIONS

A brief restatement of the work done in this investigation will be made to refresh the memory of the reader.

Since the work in the human field on motivation-shifting was so sparse and the results so ill defined as compared with those in the animal field, the present investigation was undertaken to present, if possible, a clearer picture of the effects of a change of incentive on the learning process. Since children are easier to motivate than adults, it was decided to study the effects of a shift in motivation on their learning of a sensori-motor task, the Warden Multiple-U maze, finger type. In both experiments, there were three control groups (no-reward group, verbal reward, and material reward) and two experimental groups (no reward-reward group and verbal reward-reward group). In the motivation-shifting groups a new reward was introduced in the middle of the learning period, so that the effects of the change might be studied. In the first experiment, the children were above the average in intelligence with IQ's ranging from 100 to 129; in the second, of average intelligence with IQ's ranging from 88 to 111. In the first experiment, reward, when administered, was given at the end of every trial; in the second, it was given for improvement shown. In addition, in the second experiment a group was added which had no counterpart in the first, a maximum material reward group in which a very large incentive was promised upon complete mastery of the task to be learned.

Using the results obtained from these two experiments as a basis for further discussion, the following general conclusions may be drawn:

1. On the whole, given the same conditions, certain rewards or goal-objects produce more efficient learning than others. It has been found by the animal psychologists that if different groups of rats, previously matched, run the maze with different goal-objects, some goal-objects will give a greater reduction in time and errors than others. In the present investigation, using children as subjects, it has been found that different groups, although equated according to chronological and mental age, and all possessing some knowledge of results and the goal to be reached, nevertheless

showed varying degrees of efficiency of maze performance dependent upon the type of reward used. The verbal reward group eliminated a greater number of errors than did the no-reward group, while the penny reward group eliminated still more, and the group promised twenty-five cents on complete mastery eliminated the most.

Elliott and others in the animal field have established the fact that if a more desirable goal-object is substituted for a less desirable one, marked improvement in learning will result. In the present study, it was found that when a material reward was given after a period of no-reward or verbal reward, the subjects eliminated errors to a significantly greater degree. Up to this point, then, the results found with animals and human beings parallel and support each other. The difference between the two lies in the fact that with the former a shift in motivation brings with it an almost immediate change in the learning curve, whereas with the latter, a change in the goal-object had only a delayed effect. Two explanations for this phenomenon present themselves: first, that the children, once habituated to a certain reward, are so accustomed to expecting it, that even though a new one is substituted, they still, for a few trials, continue to anticipate the old, until by dint of repetition they are assured that the change is permanent. Secondly, there is the possibility, with subjects who have already been making considerable progress under no-reward or verbal reward conditions, that it will take a much greater effort on their part before any noticeable increase in learning will be expressed in the learning curve. In other words, since the units of learning are not equal, it may take twice the amount of effort on the part of the child to reduce his number of errors from three to one, as it did to reduce them from five to three. We may conclude, then, from this, that in the human as in the animal field, certain goal-objects are more effective as motivators than are others, and a substitution of a more desirable goal-object for a less desirable one will bring about a marked improvement in learning. It must be remembered, however, that with children as subjects, a shift in motivation has a delayed effect upon the learning curve, whereas with animals the effect is immediate.

2. From this there follows an easy and natural transition to a discussion of Tolman's ''latent learning''. A distinction is drawn between learning that is ''overt'' and learning that is ''latent''. The former can be measured by the experimenter in terms of

errors, time, etc.; the latter is not outwardly expressed until a suitable goal-object has been set up. In the animal field, it was found by Tolman and Honzik that the rats under no-reward conditions showed no signs of learning, but that when the reward was introduced, the error curve dropped almost immediately to the level of the control group which had been receiving the reward from the beginning of the learning period. It is this sudden and pronounced drop which Tolman uses as his criterion for ''latent learning''. In the present study, with young children as subjects, it was found that even under no-reward conditions overt learning was being expressed. Therefore, even if, in addition, latent learning were going on under these no-reward conditions, the overt learning which had been continuous from the beginning of the period would mask any new learning which, upon the introduction of the reward, was now being expressed for the first time.

Of the four groups in which a shift in motivation occurred, only one, Group IV, fulfilled Tolman's criterion of latent learning. An alternative explanation for this one sudden drop in the error curve lies in the possibility that the substitution of a greater goal-object spurred the subjects on to such increased efforts that there was an immediate reduction in the number of errors made. We may therefore conclude that there is no need to insist upon the concept of latent learning as an explanation of this sudden drop in the learning curve of Group IV. As with the other three groups in which the goal-object was changed during the course of the learning period, we may say that here also the improvement shown was due to the increased effort on the part of the subjects upon the introduction of a more desirable goal-object.

3. Stress should be placed upon the value of the goal-object *to the subject*. As has been demonstrated in the present study the same objective reward may have varying degrees of effectiveness at different points in the learning period. A standardized verbal reward was found to lose much of its motivating power when repeated more than three or four times. At first, the praise stimulates the child to a reduction in the number of errors made, but, as the trials continue, the verbal reward loses its value to the child and thus no longer is a goal-object to be striven for. It is therefore important to remember that the value of the goal-object to the individual may vary from time to time and with it its power to motivate learning. Care should therefore be taken in the use of praise in learning experiments or in situations at home or school,

since it has been found that it rapidly loses its effectiveness with repetition.

4. From the results of the present investigation, there seems to be a strong indication that the temporal position of the goal-object (that is, the point in the learning period at which it is first introduced) is of greater importance than the number of times it is received by the individual. It was found that groups in which the reward was given in the second half of the learning period only, did just as well by the end of the period as did similar groups which had been receiving the reward from the very beginning. This would seem to point to the fact that while the subject is first gaining acquaintance with the maze, the novelty of the task plus knowledge of results is sufficient to motivate learning, but that once the subject has familiarized himself with the situation, a goal-object of greater value should be set up to spur the individual on to increased effort and therefore to increased learning. It would be more economical, then, in learning situations, to reward the subject only after the initial interest, brought about by the newness of the task, has worn off and additional motivation is needed to bring about the desired increase in learning.

5. Another point to be emphasized here which should be of interest to psychologists in the light of the many discussions as to the effect of the reward on learning is the fact that it was found in the present investigation that the goal-object need not actually be received by the subject to stimulate learning. That is to say, the promise of twenty-five cents for complete mastery was found to be more effective, although this reward was never received by most of the subjects, than a penny which was given to the subjects at the end of every trial.

According to Thorndike's ''law of effect'', a satisfying state of affairs is one which the animal does nothing to avoid but rather seeks to attain and preserve; an annoying state of affairs is one which the animal endeavors to avoid or change. If the effect of a reaction is satisfying, the reaction is stamped in or learned; if the effect is annoying, the reaction is stamped out. The after-effects of a modifiable connection, therefore, work back upon it, and in particular, a satisfying state of affairs accompanying or directly following a connection, strengthens it. With the experimental group, Group XI, however, the reward was never received by most individuals and only toward the end of the period by a few, and yet learning was taking place which was greater than that shown by the group which was receiving a penny at the end of every trial. In order to support Thorndike's point of view, the effects of a reward must work backwards to account for the strengthening of the connection, or learning. But according to the present study, the after-effects of the reward could not have worked backwards since in most cases the reward was never received. Yet the strengthening of the connection, or learning, did occur.

Two interpretations may be given to account for the above; first, that the fact that reduction of errors was being made was sufficient to bring about that ''satisfying state of affairs'' which strengthens the connection; or secondly, that it is the goal-object as something to be striven for, and not the goal-object as a reward actually possessed, which is important in motivating learning. The latter seems to be the more plausible explanation of the two, inasmuch as, if the former is assumed, we still have to account for the fact that the ''satisfyingness'' brought about by reduction of errors in Group XI was more effective in producing learning than the ''satisfyingness'' brought about by the reduction of errors plus the ''satisfyingness'' brought about by a material reward in the case of Group II.

In other words, our results seem to point to the probability that the goal-object stimulates effort and initiates activity in proportion to its value as a goal to the subject. It is the goal which stimulates learning and not its attainment since the former creates in the individual the restlessness, the energy which initiates activity, while the latter brings about quiescence and surcease from striving.

BIBLIOGRAPHY

1. Arps, G. F. A Preliminary Report on "Work with Knowledge *vs.* Work without Knowledge of Results," *Psychol. Rev.*, 1917, *24*, 449–455.
2. Bills, A. G. General Experimental Psychology, New York, Longmans, 1934, pp. 620.
3. Blodgett, H. Effect of the Introduction of Reward Upon the Maze Performance of Rats, *Univ. Calif. Publ. Psychol.*, 1929, *4*, 113–134.
4. ——————. The Relation of Reward to Animal Learning, Manuscript Ph.D. Thesis, 1925, deposited in Univ. of Calif. Library.
5. Book, W. F., Norvell, L. The Will to Learn, *Ped. Sem.*, 1922, *29*, 305–362.
6. Bruce, R. H. Effect of Removal of Reward on the Maze Performance of Rats, *Univ. Calif. Publ. Psychol.*, 1930, *4*, 203–214.
7. ——————. Effect of Removal of Reward on the Maze Performance of Rats, *Univ. Calif. Publ. Psychol.*, 1932, *6*, II, 65–73; III, 75–82.
8. Crawley, S. L. An Experimental Investigation of Recovery from Work, *Arch. Psychol.*, 1926, No. 85, pp. 66.
9. Dashiell, J. F. Fundamentals of Objective Psychology, Boston, Houghton, 1928, pp. 588.
10. Diserens, C. M., Vaughn, J. The Experimental Psychology of Motivation, *Psychol. Bull.*, 1931, *28*, 15–65.
11. Elliott, M. H. The Effect of Appropriateness of Reward and of Complex Incentives on Maze Performance, *Univ. Calif. Publ. Psychol.*, 1929, *4*, 91–98.
12. ——————. The Effect of Change of Reward on the Maze Performance of Rats, *Univ. Calif. Publ. Psychol.*, 1928, *4*, 19–20.
13. Fisher, R. A. Statistical Methods for Research Workers, 3rd edition, London, Oliver, 1930, pp. 283.
14. Garrett, H. E. Statistics in Psychology and Education, New York, Longmans, 1926, pp. 317.
15. Haggerty, M. E., Terman, L. M., Thorndike, E. L., Whipple, G. M., and Yerkes, R. M. The National Intelligence Test, prepared under the auspices of the National Research Council, Yonkers-on-Hudson, N. Y., World Book Co., 1920, pp. 4.
16. Hamilton, E. L. The Effect of Delayed Incentive on the Hunger Drive in the White Rat, *Genet. Psychol. Monog.*, 1929, *5*, 131–207.
17. Husband, R. W. A Comparison of Human Adults and White Rats in Maze Learning, *J. Comp. Psychol.*, 1929, *9*, 361–378.
18. Johanson, A. M. The Influence of Incentive and Punishment Upon Reaction Time, *Arch. Psychol.*, 1922, No. 54, pp. 53.
19. McKinney, F. Certain Emotional Factors in Learning and Efficiency, Ph.D. Thesis, 1931, Univ. of Chicago.
20. Miles, W. R. The High Relief Finger Maze for Human Learning, *J. Gen. Psychol.*, 1928, *1*, 3–14.
21. Mills, F. C. Statistical Methods, New York, Holt, 1924, pp. 604.
22. Ross, C. C. An Experiment in Motivation. *J. Educ. Psychol.*, 1927, *18*, 337–346.
23. Sharp, W. L. Disintegrative Effects of Continuous Running and Removal of the Food Incentive Upon a Maze Habit of Albino Rats, *J. Comp. Psychol.*, 1929, *9*, 405–424.
24. Simmons, R. Relative Effectiveness of Certain Incentives in Animal Learning, *Comp. Psychol. Monog.*, 1924 No. 7, pp. 79.
25. Tolman, E. C., Honzik, C. H. Introduction and Removal of Reward, and Maze Performance in Rats, *Univ. Calif. Publ. Psychol.*, 1930, *4*, 257–275.
26. Warden, C. J. The Relative Economy of Various Modes of Attack in Mastery of a Stylus Maze, *J. Exper. Psychol.*, 1924, *7*, 243–275.
27. ——————. The Value of the Preliminary Period of Feeding in the Problem Box, *J. Comp. Psychol.*, 1925, *5*, 365–372.

28. ————————, and others. Animal Motivation: Experimental Studies on the Albino Rat, New York, Col. Univ. Press, 1931, pp. 514.
29. ————————, Jenkins, T. N., Warner, L. H. Comparative Psychology, New York, Ronald, 1935, pp. 506.
30. Williams, K. A. The Reward Value of a Conditioned Stimulus, *Univ. Calif. Publ. Psychol.*, 1928, *4*, 31–55.
31. Woodworth, R. S. Psychology, New York, Holt, 1934, 3rd edition, pp. 546.
32. Young, P. T. Motivation of Behavior, New York, Wiley, 1936, pp. 562.

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